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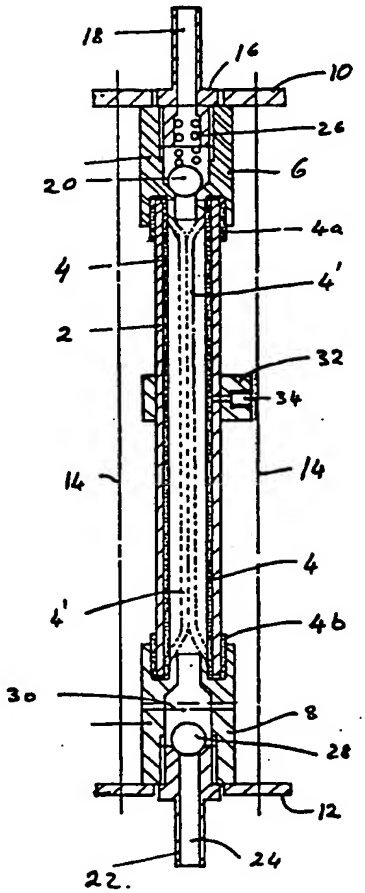
(56) Documents cited
GB A 2108211 GB 1293920 GB 0992326
GB 1433245 GB 1221144

(58) Field of search
F1W
Selected US specifications from IPC sub-class F04B

(54) Tubular diaphragm pumps

(57) A fluid pump has a tubular housing (2), containing a flexible hose (4) capable of expanding to conform to the inner walls of said housing. The housing (2) has an inlet port (24) and an outlet port (18) communicating with said hose (4). A first one-way valve (28) is provided to allow fluid to pass from the inlet port (24) to the hose (4). A second one-way valve (20) is provided to allow fluid to pass from the hose (4) to the outlet port (18). The space between the housing (2) and the hose is coupled to an alternating pressure source whereby upon the application of a relatively high pressure the hose (4) is caused to contract, to expel any fluid therein through the outlet port (18), and upon the application of a relatively low pressure the hose (4) is caused to expand to draw in fluid through said inlet port (24).



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The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1982.

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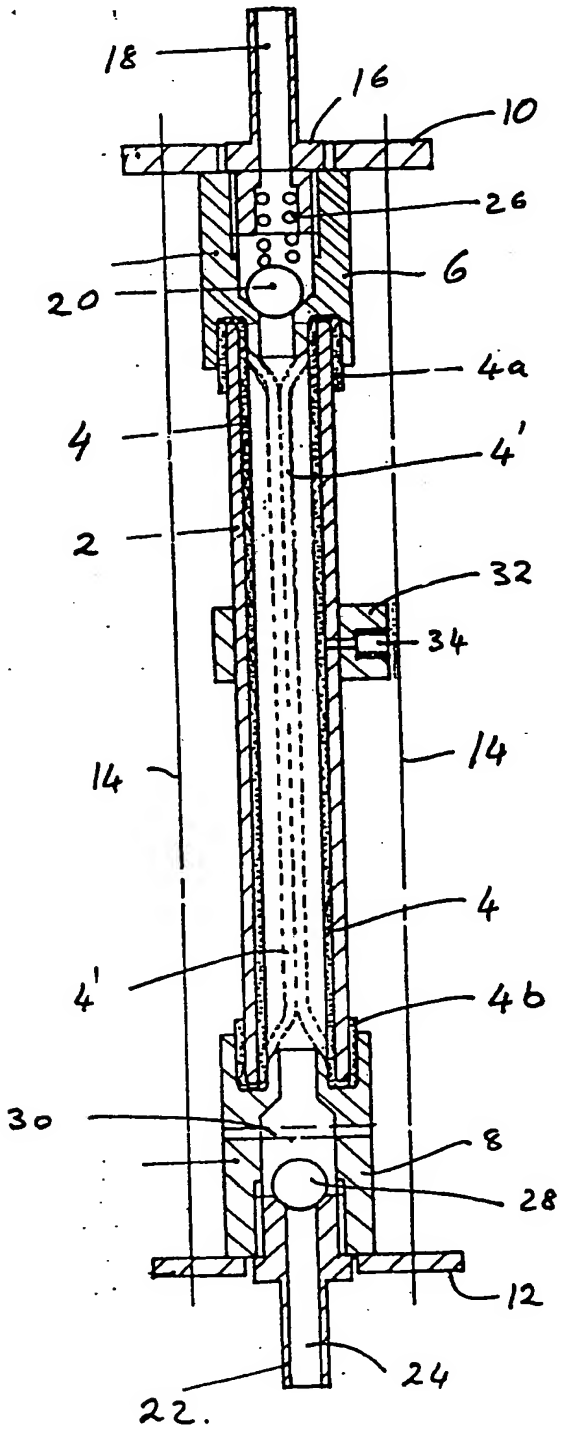

SPECIFICATION

Fluid pumps

The present invention relates to fluid pumps.

Peristaltic pumps for pumping liquids are known. In such pumps liquid is moved along flexible tube in discrete quantities by the action of a cam on the tube. The tube is thus not only subject to flexure but also to the frictional forces produced when a cam is caused to contact and slide along the tube. The life of the tube in such cases is limited. In addition, the flexible tube is subject to stretching and so there is no control on the amount of liquid in each discrete quantity displaced along the tube.

It is an object of the invention to provide an improved pump.

According to the present invention there is provided a fluid pump comprising a housing, a flexible enclosure capable of expanding to conform to the inner walls of said housing, an inlet port and an outlet port communicating with said enclosure, a first one-way valve for allowing fluid to pass from said inlet port to the enclo ure, a second one-way valve for allowing fluid to pass from said enclosure to said outlet port, and means for coupling the space between the housing and the flexible enclosure to an alternating pressure source whereby upon the application of a relatively high pressure the enclosure is caused to contract, to expel any fluid therein through the outlet port, and upon the application of a relatively low pressure,the enclosure is caused to expand to draw in fluid through said inlet port.

Advantageously the housing comprises a cylindrical tube and the enclosure comprises a length of hose lining the inner wall of the tube and having its opposite ends secured to respective ones of the opposite ends of the tube.

Preferably the hose is of rubber or plastics.

The first and second ports are defined by end caps which act to clamp the ends of the hose to the ends of the tube.

Each end cap is rigidly secured to a clamp plate and the two clamp plates are locked together by tie rods.

Advantageously each said one-way valve comprises a ball valve. The ball valve of the first one-way valve is normally urged against its valve seat by a spring. The ball valve of the second one-way valve is normally urged against its valve seat by gravity.

A fluid pump embodying the present invention will now be described by way of example with reference to the accompanying diagrammatic drawing which shows a longitudinal section through the pump.

As shown in the sole Figure the pump comprises a cylindrical housing or tube 2 which is lined with a flexible rubber hose 4. Opposite ends of the hose 4a and 4b are bent back around the adjacent extremeties of the tube 2. A pair of end caps 6 and 8 each having an annular recess for accomodating the opposite ends of the tube 2 act to clamp the hose ends 4a and 4b to the tube 2. Each end cap 6 and 8 is rigid with a corresponding clamping plate 10 and 12 and the two clamping plates 10 and 12 are drawn together by tie rods 14 (shown only as an axis).

Each end cap 6 and 8 defines a cylindrical channel which is partly internally screw-threaded.

A member 16 defining an inlet port 18 has an externally screw-threaded cylindrical portion which is in screw-threaded engagement with the end cap 6. A sealant (not shown) is provided to form a fluid tight seal between the member 16 and the end cap 6. A ball 20 is imprisioned in the cylindrical channel defined by the end cap 6. A coiled spring 26 partly housed in an enlarged diameter portion of the member 16 urges the ball towards a valve seat in the cap 6 at the downstream end of the channel.

A member 22 defining an outlet port 24 has an externally screw-threaded cylindrical portion which is in screw-threaded engagement with the internal screw-thread of the end cap 8. A sealant (not shown) is provided to form a fluid tight seal between the member 16 and the end cap 8. A ball 28 is imprisioned in the cylindrical channel defined by the end cap 8. The ball 28 is normally drawn by gravity against a valve seat defined by the member 22. An apertured plate 30 in the channel of the end cap 8 limits the movement of the ball along the channel away from the valve seat.

A generally annular body 32 envelops a central portion of the tube 2 and defines a passage 34 which communicates with the space between the tube 2 and the flexible hose 4. The passage 34 is arranged to be alternatively coupled to a source of pressure and a source of vacuum (neither of which is shown).

In operation the inlet port 24 is coupled to a supply of liquid to be pumped. The passage 34 is coupled to a source of relatively high pressure air which then fills the space between the tube 2 and the hose 4 and compresses the hose 4 to the profile 4' shown in broken lines. This action expels any air or residual fluid within the hose 4 through the one-way valve in the end cap 6 by urging the ball 20 against the bias of the spring 28. The pressure within the hose 4 causes the one-way valve in the end cap 8 to close by urging the ball 28 against its valve seat.

The passage 34 is then connected to a source of relatively low pressure, for example a vacuum. The vacuum created in the space between the tube 2 and the hose 4 will cause the hose 4 to expand into its former profile as shown in solid lines 4. This in turn will create

a vacuum within the hose 4 which will cause the one-way valve in the end cap 6 to close, assisted by the action of the spring 26 and the one-way valve in the end cap 8 to open. Liquid in the inlet port 24 will then be drawn up past the one-way valve into the hose 4 until the hose 4 is filled. At this time the passage 34 is connected again to a source of air pressure which acts on the hose 4 to expel the liquid from the hose 4 through the one-way valve in the end cap 6 into the outlet port 18. The cycle is repeated and liquid is therefore pumped in discrete quantities from the inlet port 24 to the outlet port 18.

It will be appreciated that because the tube 2 forms a rigid housing which limits the maximum extent to which the hose can expand, the discrete quantities of liquid pumped are constant in volume. Furthermore since the force applied to the hose 4 is one of uniform air pressure, the frictional action to which the hose is subjected to is minimal.

The mannner in which the passage 34 is switched alternately between a source of pressure and a source of vacuum may be effected using a standard change over fluid valve, either of the linear reciprocatry or the rotary type. The valve is operated in such a manner as to maintain communication with each source for a period sufficient to allow the hose alternately to fill with liquid and to evacuate the liquid.

In a modification, sensing means can be provided to sense when the tube is filled with liquid and empty of liquid to trigger the operation of the change-over valve. Such means may take the form of means responsive to the weight of the pump and contents or magnetic means for sensing the movement of the spherical balls 20 and 28 into this normally biassed closed positions following the completion of the filling or emptying of the hose 4. In yet another modification the tube 2 and the hose 4 may be translucent and the sensing means be optical means for sensing the opacity of the contents of the hose which would be different when the hose 4 is full of liquid and when the hose is empty of liquid.

The hose may be of plastics or other material instead of rubber.

CLAIMS

1. A fluid pump comprising a housing, a flexible enclosure capable of expanding to conform to the inner walls of said housing; an inlet port and an outlet port communicating with said enclosure, a first one-way valve for allowing fluid to pass from said inlet port to the enclosure, a second one-way valve for allowing fluid to pass from said enclosure to said outlet port, and means for coupling the space between the housing and the flexible enclosure to an alternating pressure source whereby upon the application of a relatively high pressure the enclosure is caused to contract, to expel any fluid therein through the outlet port, and upon the application of a relatively low pressure the enclosure is caused to expand to draw in fluid through said inlet port.

2. A pump according to Claim 1 wherein the housing comprises a cylindrical tube and the enclosure comprises a length of hose lining the inner wall of the tube and having its opposite ends secured to respective ones of the opposite ends of the tube.

3. A pump according to Claim 2 wherein the hose is of rubber or plastics material.

4. A pump according to any one of Claims 1 to 3 wherein the first and second ports are defined by end caps which act to clamp the ends of the hose to the ends of the tube.

5. A pump according to Claim 4 wherein each end cap is rigidly secured to a clamp plate and the two clamp plates are locked together by tie rods.

6. A pump according to any preceding claim whereln each said one-way valve comprises a ball valve, the ball valve of the first one-way valve being normally urged against its valve seat by a spring and the ball valve of the second one-way valve being normally urged against its valve seat by gravity.

7. A fluid pump substantially as hereinbefore described with reference to the accompanying diagrammatic drawing.

Published 1988 at The Patent Office, State House, 66/71 High Holborn, London WC1R 4TP. Further copies may be obtained from The Patent Office, Sales Branch, St Mary Cray, Orpington, Kent BR5 3RD. Printed by Burgess & Son (Abingdon) Ltd. Con. 1/87.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU03/00953

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: F04B 43/10, 43/113

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Refer electronic database consulted below

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI - F04B 43/08, 43/10, 43/107, 43/113, 15/02 and keywords expand, collapse and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2195149 A (S B SERVICES (PNEUMATICS) LTD) 30 March 1988 Whole document	1,4,10-16,48
X Y	WO 82/01738 A1 (RIHA) 27 May 1982 Page 12, line 37- page 14, line 15 & figures	1,4,10-16,48 2,5-9,17-24,27-32,35-36,49-50
Y	US 6345962 B1 (SUTTER) 12 February 2002 Whole document	2,8-9,35-36,40

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 August 2003	9 SEP 2003
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer R. SUBBARAYAN Telephone No : (02) 6283 2377

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU03/00953

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Derwent Abstract Accession No 99-324690/27, Q56, JP 11117872 A (IWAKI CO LTD) 27 April 1999	38-39,46,50
X	US 4543044 A (SIMMONS) 24 September 1985 Whole document	46-47,50
Y		17-24,27-32,49-50
X	US 5114319 A (FABER) 19 May 1992 Whole document	46-47,50
Y	US 4257751 A (KOFAHL) 24 March 1981	5-7
A	US 4886432 A (KIMBERLIN) 12 December 1989	
A	GB 992326 A (ESSO RESEARCH AND ENGINEERING COMPANY) 19 May 1965	
A	US 5897530 A (JACKSON) 27 April 1999	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU03/00953

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
GB	2195149	NONE					
WO	8201738	AU	77737/81	EP	73196		
US	6345962	NONE					
US	4543044	AU	35155/84	CA	1224082	DE	3441054
		FR	2554515	IN	161834	JP	60116882
		ZA	8408740	ZW	203/84		
US	5114319	EP	422745	JP	3185276	NL	8902546
US	4257751	NONE					
US	4886432	NONE					
US	5897530	EP	944405	WO	9933503		

END OF ANNEX